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Thinking ahead for Europe

Inflation-Targeting, Flexible Exchange Rates and Macroeconomic Performance since the Great Recession

Thomas Barnebeck Andersen, Nikolaj Malchow-Møller and Jens Nordvig

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Abstract

Has inflation targeting (IT) conferred benefits in terms of economic growth on countries that followed this particular monetary policy strategy during the crisis period 2007-12? We answer this question in the affirmative. Countries with an IT monetary regime with flexible exchange rates weathered the crisis much better than countries with other monetary regimes, predominantly countries with fixed exchange rates. Part of this difference in growth performance reflects differences in export performance during the initial years of the crisis, which in turn can be explained by real exchange rate depreciations. However, IT seems also to confer other benefits on the countries above and beyond the effects from currency depreciation.

JEL Codes: E42, E58, O43

Keywords: Inflation targeting, flexible exchange rates, economic growth, Great Recession

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1. Introduction

Does the choice of exchange rate and monetary regime matter for economic growth? In his paper on exchange rate regimes in the modern era, Rose (2011) argues that "views appear to be strongly held and sincere, yet they seem to have neither discernible causes nor visible consequences" (p. 621). Indeed, Rose concludes the paper by noting that: "the stakes could not be lower" (p. 621).

Nevertheless, a fairly new monetary regime – a floating/flexible exchange rate with an inflation target (IT) – has gained an increasing number of adherents, at least since the Asian crisis of 1997-98.[1] Bernanke and Mishkin (1997) and Bernanke et al. (2001), for example, argue that the potential benefits to be obtained from the adoption of an IT regime are substantial. Some of the purported gains are lower and less variable inflation and interest rates, more stable growth and an enhanced ability to respond to shocks without losing credibility. Others have added that IT countries may be better adapted to dealing with an economic crisis. In particular, a credible IT regime may allow for greater monetary easing without jeopardising the inflation outlook; and, in a time when deflationary risks are looming large, the credibility of an IT regime can certainly play an important role in avoiding a liquidity trap (Krugman, 1999). This type of thinking was, for example, behind the Bank of Japan's decision to formally adopt an IT regime in early 2013.

A central element of an IT regime is the flexibility of the exchange rate. This may prove important in a crisis. For instance, consider the immediate response to the crisis in Sweden: The central bank significantly lowered policy rates, which led to currency depreciation, improved Swedish competitiveness and caused an increase in exports (OECD, 2011).[2] This echoes important research on the Great Depression, where it has been shown that currency depreciation conferred important macroeconomic benefits (not necessarily beggar-thy-neighbour effects) on initiating countries (see Eichengreen and Sachs, 1985; Bernanke, 1995).

* Thomas Barnebeck Andersen (barnebeck@sam.sdu.dk) and Nikolaj Malchow-Møller (nmm@sam.sdu.dk) are in the Department of Business and Economics, University of Southern Denmark. Jens Nordvig is Head of Fixed Income Research Americas, Nomura Securities (jnordvig@me.com).

[1] We follow Rose (2011, 2014) and distinguish between three categories of monetary regimes: i) hard fix, ii) floating/flexible exchange rates with inflation targeting and iii) other regimes, including soft pegs and floats with other targets than inflation. We will return to this issue below.

[2] The SEK currency move also reflected tensions in global interbank markets, which affected Swedish banks with large dollar liabilities and thereby depressed the SEK by forcing USD buying and SEK selling; see, for example, Nomura Securities (2009).

Such a (unilateral) response to a crisis would be impossible under an inflexible exchange rate, including hard and soft pegs. Here, a country would have to follow the monetary policy of the country to which its currency is pegged or, in the case of a currency union, rely on a concerted effort. This leads to a related problem with monetary policy under inflexible exchange rates, namely "when one size does not fit all" (Nechio, 2011). For example, simple Taylor-rule recommendations for the eurozone as a whole have been broadly consistent with ECB policy, but the more pertinent question concerns the appropriateness of the eurozone rate both for the individual eurozone economies and for the countries that have a fixed exchange rate vis-à-vis the euro.

Denmark, a country with a fixed exchange rate vis-à-vis the euro, is a case in point. By the fall of 2005, the first signs of 'overheating' were beginning to show in Denmark (OECD 2005). Yet, monetary conditions appropriate for the eurozone as a whole were providing stimulus to the Danish economy. By the spring of 2006, when the economy was clearly overheated, monetary policy was still adding fuel to the economy (OECD, 2006). Hence, the OECD recommended that fiscal policy should be tightened, and reiterated the urgency of increasing labour supply, both by strengthening work incentives and by making it easier for foreigners to enter sectors like construction. The government did not comply. At this juncture, the obvious policy would have been an interest rate increase – as clearly recommended by a simple Taylor rule (OECD, 2008) – but such policy was ruled out by design. The upshot of all this, it has been argued, was that Denmark suffered a deep and prolonged economic crisis (Sørensen, 2013).

The present paper analyses whether flexible exchange rates with an inflation target conferred benefits in terms of economic growth during the crisis years 2007-12 on countries that followed this particular monetary strategy relative to countries that adhered to other strategies, in particular a fixed exchange rate regime. Our analysis proceeds in two steps. First, we consider the set of OECD countries, where all countries (except two) operated under either an IT regime or a fixed exchange rate regime in the period considered. Second, to enhance the robustness of our results, we also look beyond the OECD. The advantage of doing so is that we can enlarge the sample by more countries. The disadvantages, which should not be overlooked, are first that data quality is lower, and second that we cannot control for the same type of variables as when only considering OECD countries. The second disadvantage is minimised by the fact that we have a good instrumental variable (for the monetary regime) at hand. Furthermore, looking beyond the OECD also allows us to include other alternatives to IT such as soft pegs and floats with other targets than inflation in the comparison group.

Our results show that countries with an IT monetary regime weathered the financial crisis much better than countries with alternative regimes – predominantly countries with a fixed exchange rate. This holds in the full OECD sample; it holds when we exclude the five so-called peripheral eurozone countries (Greece, Italy, Ireland, Portugal and Spain); and it holds when we exclude all eurozone countries. IT also outperforms the fixed exchange rate regime in the extended sample with more than 100 countries – also when instrumenting the choice of monetary regime. It also holds when we include alternatives to a fixed exchange rate regime in the comparison group. It is, in other words, a robust empirical finding.

Using the OECD sample, we also show that the explanation for this difference in growth performance is, to some extent, found in differences in export growth during the initial years of the crisis. The difference in export performance may in turn be explained by the fact that IT countries on average experienced larger real (effective) exchange rate depreciations in the initial years of the crisis. However, we also find that real exchange rate depreciations can only explain part of the difference in performance between IT and non-IT countries. Thus, IT also appears to have had other positive effects, which we do not identify in the present paper.

Some caveats are in order concerning the extent to which our findings lend themselves to generalisations. Looking at a short and extraordinary period of five years is risky if one wants to draw general conclusions about the merits of a certain monetary regime. Yet, it makes sense to single out the time period 2007-12 *exactly* because it is extraordinary. The world has experienced the worst crisis since the Great Depression; activist monetary policy is operating in unchartered territory; and there is even talk about an enduring negative *natural* rate of interest (or, equivalently, that the liquidity trap is no longer an exceptional state of affairs going forward – it is the new normal).[3] In this light, the 2007-12 period may be one of the best tests of the relative performance of different monetary regimes. Indeed, since a widespread view before the crisis held that different monetary regimes performed equally well, the fact that IT outperformed the hard fix during the crisis should certainly count for something.

Our paper is related to a number of earlier empirical studies exploring the economic consequences of IT. Analysing the period 1960-2002, Ball and Sheridan (2004) show that adopting IT appears to have been irrelevant for a group of 20 developed economies, entailing neither gains nor losses in terms of economic performance. Analysing a group of emerging economies, Gonçalves and Salles (2008) show that IT did appear to matter for these economies. Rose (2014) explores the growth consequences of monetary regimes during 2007-11, and he does not find a positive effect of IT on growth. The reason for this 'non-finding' may be that Rose does not employ a growth regression. Instead, he compares time-demeaned growth rates across regimes. Moreover, he also excludes large countries as well as the entire eurozone. Our paper is also related to de Carvalho Filho (2010). Combining developed and emerging economies, he explores the implications of inflation targeting for various economic indicators with data through 2009. He finds, among other things, that IT countries had higher GDP growth.

Our paper differs from the aforementioned papers in several important respects. First, and most importantly, we analyse more recent data. Like Rose (2014), this allows us to include the European sovereign debt crisis years in our observation window. The eurozone crisis exploded in May 2010 and stabilised in the summer of 2012 when Mario Draghi pledged to do "whatever it takes to preserve the euro."[4] Our observation window, 2007-12, captures both these events. Second, our empirical methodology is different from all the aforementioned papers. Finally, we also pay closer attention to the potential endogeneity of the monetary regime. In particular, we show using OLS, random effects, instrumental variables and treatment-effects regressions that IT countries had higher growth than non-IT countries during 2007-12.

Our paper is also related to research on the Great Depression such as Eichengreen and Sachs (1985) and Bernanke (1995), who emphasise the role of currency depreciation (i.e. going off gold) in escaping the negative growth dynamics of the Great Depression.

A final caveat is warranted. Whelan (2013) voices concerns that IT can restrict central banks in their ability to get us out of the crisis. While this paper shows that inflation targeting with flexible exchange rates has done better than fixed exchange rates, it does not address the issue of whether untested alternatives such as nominal GDP targeting would do better.

The paper is structured as follows. In section 2 we briefly discuss the concept of inflation targeting; sections 3 and 4 contain our empirical analyses of the OECD sample and the extended sample, respectively; and section 5 concludes.

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[3] See, for example, remarks by Paul Krugman (http://krugman.blogs.nytimes.com/2013/11/16/secular-stagnation-coalmines-bubbles-and-larry-summers/.)

[4] The notorious speech by ECB President Mario Draghi was delivered on 26 July 2012 in London.

2. What is inflation targeting?

The Reserve Bank of New Zealand was the first central bank to adopt inflation targeting (IT) in 1990. This move was part of a wider political aim, which entailed giving public-sector bodies a clear, simple and quantifiable target to which they could be held accountable (Davies and Green, 2010). As such, inflation targeting can be said to have been derived from a political initiative. Yet IT was fully consistent with important erstwhile theoretical developments in economics.

Specifically, IT as a monetary policy regime was stimulated by two key intellectual understandings: i) Friedman's (1968) insight that there is no long-run trade-off between inflation and output, and ii) the literature on dynamic inconsistency initiated by Kydland and Prescott (1977).

Friedman's insight excited economists about the idea that central banks should focus on what they could control, viz. the inflation rate; and since people tend to dislike inflation, it should be a low one. Kydland and Prescott's work taught that because of a short-run trade-off between inflation and output, it was important to ensure that central banks would resist the temptation to 'cheat' on an inflation target (Bernanke and Mishkin, 1997; Whelan, 2013).

In theory, the mechanics of IT are pretty straightforward. The central bank forecasts the future path of inflation using all available information – including the current and possibly the future monetary stance – and it compares the forecast with the target inflation rate. The difference between the two determines how much monetary policy has to be adjusted. IT should not be understood as a strict pre-commitment to a policy rule (Bernanke and Mishkin, 1997; Bénassy-Quéré et al., 2010). The target is sometimes set as a range (say 1-3%), in which case the central bank is left with considerable discretion regarding where in the range it wants to be, and sometimes as an exact number, leaving the central bank with less discretion. In both cases, IT provides a rule-like framework within which the central bank has some discretion to react to shocks (Bénassy-Quéré et al., 2010). At the same time, inflation targeting is typically (although not necessarily) accompanied by flexible exchange rates, which has the potential to make the economy more resilient to external shocks. To the extent that intermediate targets, such as the exchange rate, are used, the inflation goal will take precedence in case of conflict (Bernanke and Mishkin, 1997). In the empirical analysis below, IT countries are defined as countries with an inflation target *and* a floating exchange rate.

IT has received much criticism since the crisis began (see e.g. Whelan, 2013). Critics hold that IT focused too narrowly on consumer price inflation in the run-up to the crisis, thereby ignoring asset price inflation and related financial stability issues. It has also been claimed that IT resulted in expected inflation that was too low. With the economy trapped near the zero lower bound for nominal interest rates, this has made it difficult to reduce real interest rates and provide monetary stimulus (Japan is a key example of this up to recently). Yet, the credibility embedded in IT has also been heralded as providing a route out of a liquidity trap by helping the central bank to "credibly promise to be irresponsible" (Krugman, 1999).

Hence, there has been plenty of debate about the merits of IT as a monetary regime, and its ability to secure superior macroeconomic outcomes relative to alternative monetary policy regimes. However, there is little consensus at this point.

3. Empirical analysis: OECD sample

In this section we use simple regression analysis to examine whether OECD countries with flexible exchange rates and IT have outperformed countries with alternative monetary regimes – in particular countries with fixed exchange rates – in the period 2007-12. As a first step, we look at simple differences in terms of average growth between IT and non-IT countries. As a second step, we add control variables in a simple growth-regression framework. In a third and final step, we analyse the potential role of real exchange rate depreciations in explaining the difference in growth performance between IT and non-IT countries.

3.1 IT and average growth

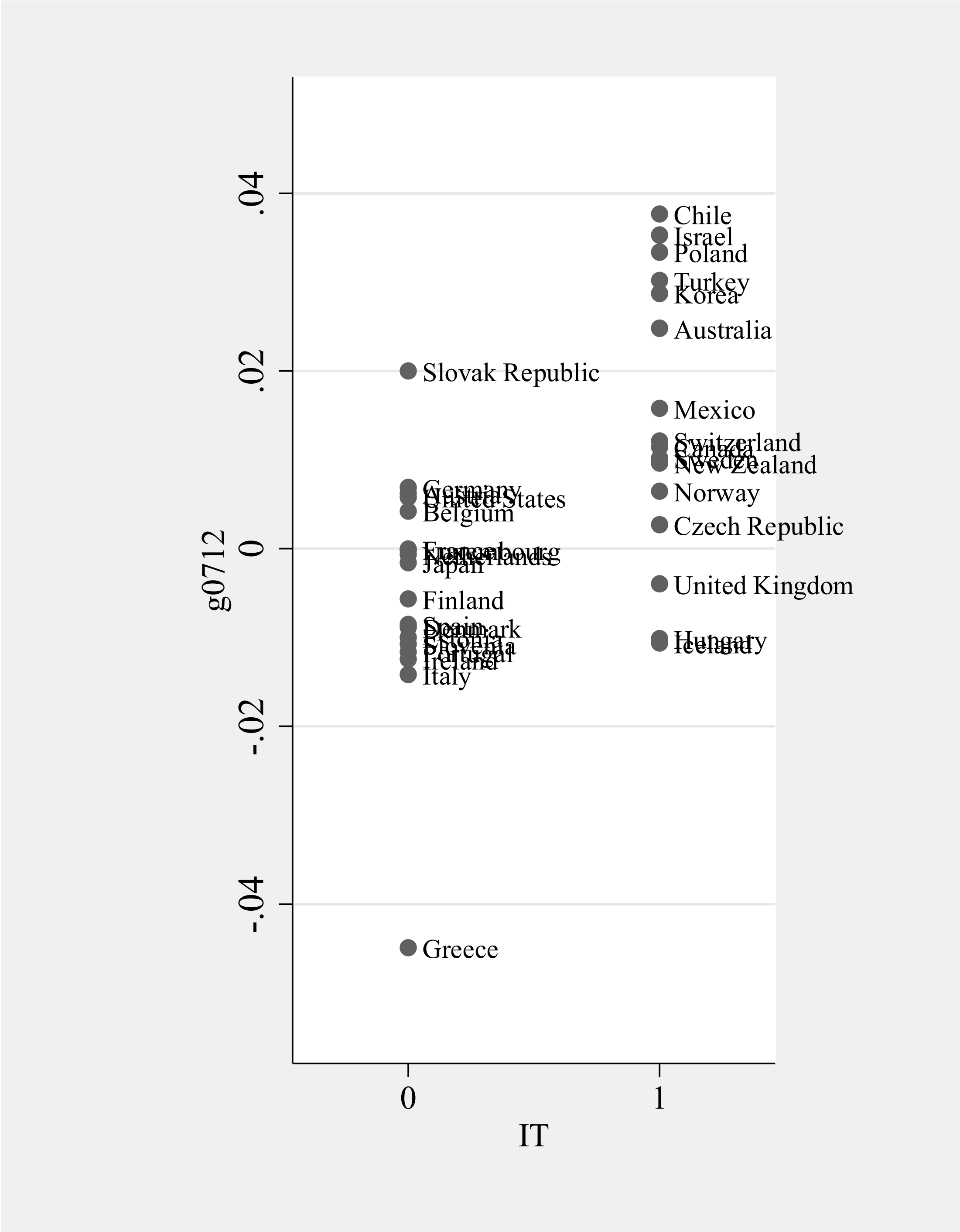
According to IMF researchers, 16 of the 34 OECD member countries had adopted IT with flexible exchange rates by 2007. These 16 countries are Australia, Canada, Chile, Czech Republic, Hungary, Iceland, Israel, Mexico, New Zealand, Norway, Poland, South Korea, Sweden, Switzerland, Turkey and the UK.[5] Equally many countries (Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Slovak Republic, Slovenia and Spain) had chosen fixed exchange rates in the form of a conventional peg (Denmark) or a common currency (the rest), while just two countries (Japan and the US) had chosen flexible exchange rates without IT.[6] This leaves us with 18 non-IT countries in total in the OECD. It should be noted that two countries, Slovakia and Estonia, changed their monetary regime during our observation window, 2007-12. Specifically, Slovakia joined the eurozone in 2009 and Estonia in 2011. We have coded them as fixed exchange rate regimes, but, as we show below, the results are robust to excluding these two countries. Moreover, coding Estonia as an IT country also has no implications for our results.

As a first step in investigating whether IT countries have grown faster than non-IT countries, consider Figure 1, which plots average annual real GDP growth between 2007 and 2012 against a dummy variable equal to 1 if the country is pursuing IT, and zero otherwise. The six top performing IT countries in terms of economic growth (Chile, Israel, Poland, Turkey, Korea and Australia) grew faster than the single top-performing non-IT country (Slovakia). Moreover, in between Slovakia and the second best-performing non-IT country (Germany) are five IT countries (Mexico, Switzerland, Canada, Sweden and New Zealand). At the same time, non-IT countries are also clustered at the bottom of the (unconditional) growth distribution. The five worst performers (Greece, Italy, Ireland, Portugal and Slovenia) are all non-IT countries. Indeed, four of them are members of the notorious group of so-called peripheral eurozone countries. Consequently, simply eyeballing the (conditional) growth distributions immediately indicates a systematic difference in growth performance between IT and non-IT OECD countries.

[5] Data on inflation targeting are from Sarwat (2012) and de Carvalho Filho (2010). There is a discrepancy between the coding of Switzerland in these two sources. According to the homepage of the Swiss central bank, it follows an IT strategy – more specially, it states that it bases its monetary policy on a medium-term inflation forecast. We therefore code it as an IT country. Real GDP data are from OECD (2013).

[6] As such, we essentially compare IT with a fixed exchange rate regime. Note that the US introduced elements of inflation targeting in 2012, but we do not take that into account since it was at the end of our observation window. Yet if we include the US in the group of IT countries, the results only become stronger.

Figure 1. Real GDP growth, 2007-12, in countries without (IT = 0) and with (IT = 1) inflation targeting

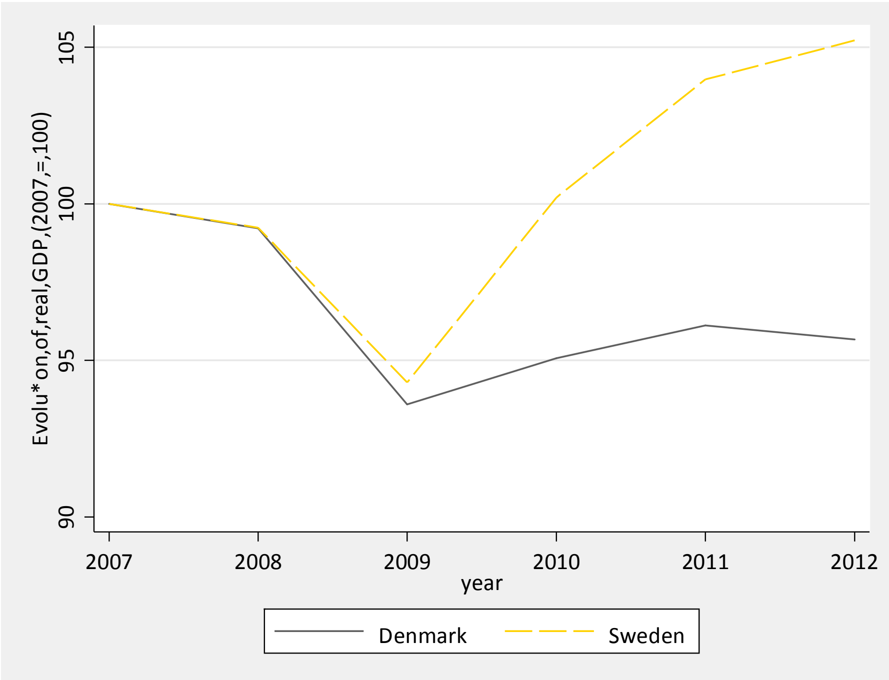


Note: Ordered from lowest to highest growth rates, the countries ranked in the figure are (**IT = 1 in boldface**): Greece, Italy, Ireland, Portugal, Slovenia, **Iceland**, **Hungary**, Estonia, Denmark, Spain, Finland, **United Kingdom**, Japan, Netherlands, Luxembourg, France, **Czech Republic**, Belgium, United States, Austria, **Norway**, Germany, **New Zealand**, **Sweden**, **Canada**, **Switzerland**, **Mexico**, Slovak Republic, **Australia**, **Korea**, **Turkey**, **Poland**, **Israel**, **Chile**.

Data sources: See Table 1.

A similar impression emerges upon comparing two neighbouring Nordic countries, Denmark (non-IT) and Sweden (IT). These two countries are very similar in a great many respects, not least culturally, politically and economically. Both countries entered the crisis with a large drop in GDP, as revealed by Figure 2. As also revealed by the figure, Sweden returned to the pre-crisis GDP level by 2010, whereas Denmark still has not managed to make up for lost ground. As we will argue below, the monetary regime holds significant explanatory power in terms of accounting for the differences in GDP trajectories of these two countries.

Figure 2. Evolution of real GDP (2007 = 100) for Denmark (IT = 0) and Sweden (IT = 1)



To be a bit more systematic than merely eyeballing and (selectively) choosing country cases to compare, consider regressing average annual real GDP growth between 2007 and 2012, *g*0712, on the IT dummy variable. This is simply a test of whether the means are different in the two subgroups. Results from this exercise are reported in column 1 of Table 1. Inspection of the table reveals that average annual growth in the 18 countries that did not pursue inflation targeting (IT = 0) was -0.48%. For the group of inflation-targeting countries (IT = 1), average annual growth was 1.42%. This amounts to a statistically significant average annual growth difference of almost 2 percentage points. Removing the US and Japan from the group of non-IT countries would only increase this difference.

In column 2 of Table 1 we exclude the five peripheral eurozone countries: Greece, Italy, Ireland, Portugal and Spain. Recall from the discussion above that four of these countries were the worst-performing countries in the entire (unconditional) growth distribution, for which reason excluding them makes sense as a robustness check. Yet, omitting them changes very little. IT countries have still outperformed non-IT countries by some (statistically significant) margin; 1.46 percentage points to be precise.

In column 3 we exclude the 15 OECD countries that are eurozone members – leaving us with Denmark, Japan and the US as the only remaining non-IT countries – and again the basic conclusion remains. In the remaining columns we change the period over which the GDP growth rate is calculated to 2008-12, and again with no implications for the result.

In sum, viewing the empirical evidence in a straightforward manner and from different angles – visually, case-wise and statistically – leads to the same conclusion: IT countries have weathered the financial crisis much better than the non-IT countries in the OECD.

As noted, Slovakia and Estonia changed their monetary regime during our observation window. These two countries do not drive our results, as they were excluded from the sample with the group of all eurozone countries; i.e., they are excluded in columns 3 and 6 of Table 1.

Table 1. IT and average annual real GDP per capita growth in the OECD, 2007-12 (OLS estimation)

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.	*g*0712	*g*0712	*g*0712	*g*0812	*g*0812	*g*0812
IT	0.0194***	0.0142***	0.0161***	0.0210***	0.0152***	0.0146**
	(0.0050)	(0.0046)	(0.0054)	(0.0056)	(0.0050)	(0.0062)
Constant	-0.0048	0.0004	-0.0016	-0.0065*	-0.0007	-0.0001
	(0.0032)	(0.0023)	(0.0036)	(0.0036)	(0.0024)	(0.0043)
Obs.	34	29	19	34	29	19
R-squared	0.320	0.239	0.147	0.305	0.232	0.103
Excluded	None	Peripheral	Eurozone	None	Peripheral	Eurozone

Notes: The table reports OLS regressions. Peripheral countries are Greece, Italy, Ireland, Portugal and Spain. Real GDP growth between t and T is calculated as $g = \log(Y_T/Y_t)/(T-t)$, where Y_t is real GDP in year t. Coding of *IT* is based on Sarwat (2012) and de Carvalho Filho (2010), whereas real GDP data are from OECD (2013). Robust standard errors are reported in parenthesis.

3.2 Cross-sectional growth regressions

The evidence brought to bear so far cannot tell us whether IT countries did better because they entered the crisis in better shape (or had other advantages) – thus being better positioned to deal with it in terms of fiscal stimulus, say – or, alternatively, because the increased flexibility that comes with an independent monetary policy enabled IT countries to better navigate the crisis. Consequently, this dictates that we control for the overall 'health' of the macroeconomy in 2007, when the global financial crisis started to reverberate.

We therefore estimate the following simple cross-sectional growth-regression model:

$$(1) \quad g0712_i = a_0 + a_1 \cdot IT_i + a_2 \cdot GAP_i + a_3 \cdot gPY_i + a_4 \cdot PR_i + a_5 \cdot DEBT_i + u_i$$

where $g0712_i$ is average annual real GDP growth between 2007 and 2012 for country i. IT_i is our inflation-targeting dummy, and GAP_i is the output gap in country i in 2007, as reported by the OECD in its 2013 Economic Outlook database (OECD, 2013). Growth of potential GDP, gPY_i, is calculated over the period 1997-2007, with the level of potential GDP also being from OECD (2013). The price-to-rent ratio in 2007, PR_i, is a widely used indicator of housing market conditions, which captures the cost of owning a house versus renting it (André, 2010). It is measured as the ratio of nominal house prices to the rent ratio of the consumer price indicator. A large positive deviation of the price-to-rent ratio from its historical average is an indication of overvaluation, and vice versa for a negative deviation. Housing data are from the online annex tables to the Economic Outlook.[7] $DEBT_i$ is gross public debt (Maastricht criterion) as a percentage of GDP in 2007; it is from OECD (2013).

[7] Available on the OECD website (http://www.oecd.org/eco/outlook/economicoutlookannextables.htm).

Some motivation for this specification runs as follows: A large output gap indicates that productive capacity is unable to keep up with growing aggregate demand; i.e. growth is occurring at an unsustainable rate. Such economic 'overheating' is generally followed by lower than average economic growth because of the need for a 'correction'. At the same time, the output gap captures regression-towards-the-mean effects. A priori, we therefore expect $a_2 < 0$.

The growth rate of potential output captures whether the economy's 'speed limit' has increased in the period leading up to the crisis. If IT countries have implemented more favourable economic reforms than non-IT countries, then the growth rate of potential output will pick up this effect. Including this variable should therefore greatly reduce the scope for omitted-variable bias. The flip side of this is that any general positive effect on growth of IT compared to non-IT that was also present before the crisis will be removed. This implies that by including the potential growth rate among the regressors, we are in reality estimating the 'extra' effect of IT on post-crisis growth. Thus, we should expect the inclusion of potential growth to reduce the estimated effect of IT. A priori, we expect $a_3 > 0$.

The amount of house price overvaluation in 2007 is expected to have a negative impact on subsequent growth ($a_4 < 0$) by amplifying the negative effects of the crisis. This could happen in various ways. Consumption demand, for example, is likely to be negatively affected by a (larger) crisis-induced drop in house prices through both a wealth effect and a collateral effect. Furthermore, although residential investment is a small component of GDP, it is rather volatile and may have a large impact on economic growth, and residential construction is labour intensive, thus influencing employment in important ways.

Finally, the amount of public debt (as a share of nominal GDP) will among other things determine the course of the fiscal response to the crisis. Large debt means higher taxes and/or lower public spending; it also determines the degree of frontloading of the eventual fiscal consolidation measures. Different countries can – depending on macroeconomic history – tolerate different levels of debt to GDP, so this variable will probably have a heterogeneous effect. For this reason, the point estimate may be difficult to interpret, although we will expect it to be negative ($a_5 < 0$).

Table 2 reports the results of the estimation. Only *GAP* is available for all 34 OECD countries; we lose three observations when we add *gPY*, another six when we add *PR*, and yet another eight when we add *DEBT*.[8] Column 1 therefore starts with regressing GDP growth on *IT* and *GAP*. This simple regression explains 42% of the variation in growth. Moreover, the estimated coefficient of *GAP* has the expected sign and is statistically significant. With *IT*, *GAP*, and *gPY* as controls, 60% of the variation in economic growth during the crisis is explained, cf. column 2. Yet, as sample sizes differ, values of R-squared cannot be compared across columns. As expected, the coefficient of IT drops when we control for potential output growth. Still, there seems to be an 'extra' post-crisis effect of IT compared to non-IT.

Adding, respectively, *PR* in column 3 and *DEBT* in column 4 changes nothing qualitatively. While the point estimate of IT changes somewhat across columns, which is not too surprising

[8] Instead of using debt to GDP (Maastricht criterion), we can also use general government gross financial liabilities to GDP. The concept of general government financial liabilities applied in the OECD Economic Outlook is based on national accounting conventions. These require that liabilities are recorded at *market prices* as opposed to *constant nominal prices* (as is the case for the Maastricht definition of general government debt). If we use general government gross financial liabilities to GDP, we can increase the number of observations, and with a correlation between the two measures of 0.9, it appears to be worthwhile estimating equation (1) with this alternative debt measure. Consequently, Appendix Table A1 re-estimates Table 2 using this alternative variable. As shown in the Table, all our conclusions stand.

given the changes in the sample size, it stays statistically significant. Table 3 repeats the estimations of Table 2, but now using growth over the period 2008-12 as the dependent variable. This has only trivial implications for our results.

Table 2. IT and average annual real GDP per capita growth in the OECD, 2007-12 (OLS growth regressions)

	(1)	(2)	(3)	(4)
Dep. Var.	*g*0712	*g*0712	*g*0712	*g*0712
IT	0.0164***	0.0082*	0.0084**	0.0143**
	(0.0046)	(0.0047)	(0.0040)	(0.0058)
GAP	-0.0022**	-0.0054***	-0.0050**	-0.0038
	(0.0010)	(0.0013)	(0.0018)	(0.0025)
gPY		0.0740***	0.0689**	0.0293
		(0.0213)	(0.0262)	(0.0357)
PR			-0.0001	-0.0002
			(0.0001)	(0.0001)
DEBT				-0.0003*
				(0.0001)
Constant	0.0062	0.0009	0.0144	0.0421*
	(0.0047)	(0.0064)	(0.0101)	(0.0217)
Obs.	34	31	25	17
R-squared	0.419	0.597	0.548	0.554

Notes: The table reports OLS growth regressions of the type $g0712_i = a_0 + a_1 \cdot IT_i + a_2 \cdot GAP_i + a_3 \cdot gPY_i + a_4 \cdot PR_i + a_5 \cdot DEBT_i + u_i$. The variables *g*0712 and *IT* are described in the text below Table 1. New variables are *GAP* (output gap), *gPY* (growth of potential output), *PR* (house-price-to-rent ratio), and *DEBT* (gross-debt-to-GDP ratio). All new data are from the OECD. Robust standard errors are reported in parenthesis.

Table 3. IT and average annual real GDP per capita growth in the OECD, 2008-12 (OLS growth regressions)

	(1)	(2)	(3)	(4)
Dep. Var.	*g*0812	*g*0812	*g*0812	*g*0812
IT	0.0180***	0.0089*	0.0098*	0.0185**
	(0.0053)	(0.0050)	(0.0047)	(0.0065)
GAP	-0.0021	-0.0060***	-0.0058**	-0.0041
	(0.0014)	(0.0016)	(0.0022)	(0.0028)
gPY		0.0741***	0.0723**	0.0208
		(0.0211)	(0.0272)	(0.0358)
PR			-0.0001	-0.0002
			(0.0001)	(0.0001)
DEBT				-0.0003*
				(0.0002)
Constant	0.0044	0.0019	0.0136	0.0484*
	(0.0061)	(0.0065)	(0.0118)	(0.0229)
Obs.	34	31	25	17
R-squared	0.384	0.593	0.566	0.628

Notes: The table reports OLS growth regressions of the type $g0812_i = a_0 + a_1 \cdot IT_i + a_2 \cdot GAP_i + a_3 \cdot gPY_i + a_4 \cdot PR_i + a_5 \cdot DEBT_i + u_i$. The variables are described in the text below Tables 1 and 2. Robust standard errors are reported in parenthesis.

Now the obvious question is: How large is the effect of having an IT regime? As IT is a 0/1 dummy, multiplying the parameter estimate of a_1 by 100 gives us the growth effect in percentage points of switching from IT = 0 to IT = 1. A relatively conservative approach based on Table 2 would use a parameter estimate of 0.01. With this estimate, we find that a shift in 2007 from not pursuing inflation targeting (IT = 0) to adopting it (IT = 1) would have increased average annual real GDP growth by one percentage point.

Consequently, the robust message that emerges from investigating the empirical evidence in different ways is that OECD countries with inflation targeting have weathered the crisis much better than OECD countries pursuing a different monetary policy strategy, i.e. predominantly countries with a fixed exchange rate regime.

So far we have not paid explicit attention to potential endogeneity of the monetary regime due to omitted (unobserved) variables in (1). This will receive much more attention in a later section. However, an interesting way to gauge the potential effects of this is by using the approach of Altonji et al. (2005). Essentially we ask the following question: How much stronger must selection on unobservables (i.e. omitted variables) be relative to selection on observables in order to explain away the entire estimated effect from IT?[9] Specifically, consider two regressions: one (F) with a full set of controls, which should be representative

[9] We employ a specialisation of the Altonji et al. (2005) approach to the linear model not assuming joint normality, which is developed in Bellows and Miguel (2008). See also Nunn and Wantchekon (2011).

of all possible observable controls, and one (N) with no control set. Denote the IT point estimates from the first and second regression as $\hat{a}_1^F$ and $\hat{a}_1^N$, respectively. We are then interested in the ratio $\hat{a}_1^F/(\hat{a}_1^N - \hat{a}_1^F)$. The larger this ratio, the less plausible it is that omitted variables can explain away the entire estimated effect of IT on economic growth. The intuition is simple: the smaller the denominator, the less the IT estimate is affected by controlling for observables, and the larger the ratio. Also, the larger the numerator, the larger is the total effect that needs to be explained away.

In order to quantify this ratio, we use column 1 of Table 1 to retrieve $\hat{a}_1^N = 0.0194$ and column 4 of Table 2 to retrieve $\hat{a}_1^F = 0.0143$. We thus (courageously) assume that *GAP*, *gPY*, *PR*, and *DEBT* are representative of all observable controls. This is not entirely farfetched; column 4 of Table 2 does explain more than 55% of the variation in economic growth during 2007-12.

Inserting the estimated coefficients into the expression, $\hat{a}_1^F/(\hat{a}_1^N - \hat{a}_1^F)$, the ratio becomes $0.0143/(0.0194 - 0.0143) = 2.80$. Hence, in order for unobservable controls to explain away the entire estimate of IT's impact on economic growth in column 4 of Table 2, their effect on the estimate should be almost three times that of the observable controls. In other words, the selection on unobservables should be almost three times as strong as the selection on observables. This seems improbable given the control set in column 4 of Table 2.

3.3 Inflation targeting, real effective exchange rates and export growth

To understand why OECD countries with an IT strategy have done better than other OECD countries, consider again Sweden, which is a country with an IT framework. According to the OECD (2011), Sweden's immediate response to the crisis was to significantly lower its policy interest rate. The Swedish real exchange rate depreciated, with the direct consequence being an improved Swedish competitiveness.[10] Neighbouring Denmark, which has a fixed exchange rate against the euro, did not slash interest rates as aggressively as Sweden because the ECB did not. Therefore, it did not see the real exchange rate depreciate. This difference between Denmark and Sweden appears to be part of a more general trend. As argued by de Carvalho Filho (2010), IT countries lowered policy rates by more than non-IT countries in the initial years of the crisis; and with their flexible exchange rate regimes, IT countries also saw sharper real depreciations.

To investigate this channel more systematically, we define the change in the real effective exchange rate between 2008 and 2009 as $DREER = REER_{2009} - REER_{2008}$, where *REER* is the real effective exchange rate with constant trade weights from OECD (2013), and $DREER < 0$ represents a depreciation. We then regress *DREER* on *IT*; see columns 1-3 of Table 4. Consistent with the dynamics described above, *IT* countries saw their real exchange rates depreciate, and thus their export competitiveness improve. On average, IT countries experienced 7 percent depreciation while non-IT countries experienced 3 percent appreciation over the period 2008-09, cf. column 1 of Table 4.

Columns 4 to 6 of Table 4 explore whether this improvement in export competitiveness on average was associated with an increase in the export volume. More specifically, we regress growth in export volume in the first years of the crisis (2008-10) on *DREER*.[11] We denote the export growth variable by *gx*0810, and we use export volume of goods and services in

[10] With inflation being low, nominal exchange-rate movements obviously dominate price movements in the real exchange rate.

[11] Given J-curve dynamics, one may reasonably wonder whether this is the appropriate period length. Had we instead used 2008-11, the results would essentially be the same as those reported in columns 4 to 6 of Table 4.

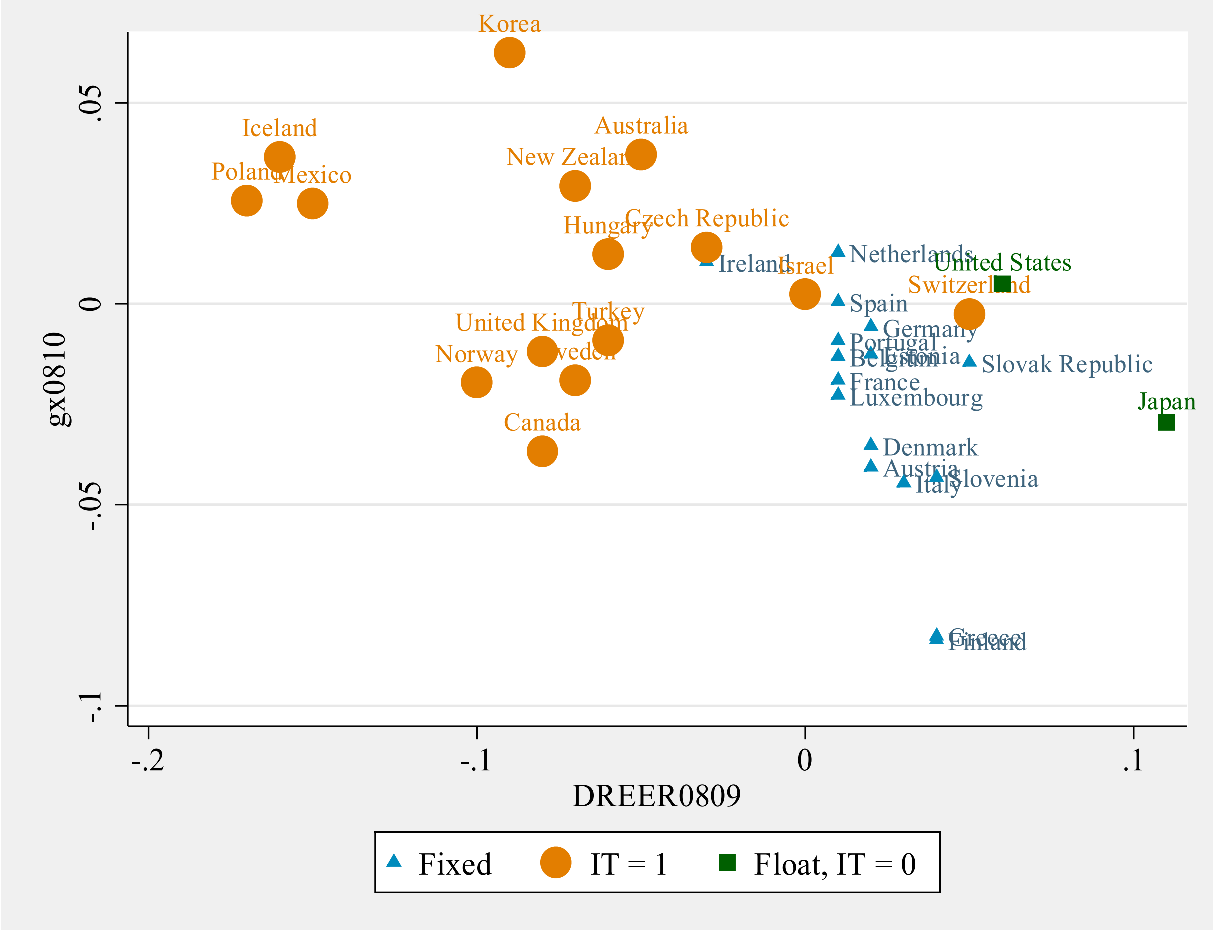
constant 2005 USD from OECD (2013) to construct it. Examination of columns 4-6 shows that *DREER* indeed predicts export growth. This is also evident from Figure 3, which also shows how little the real effective exchange rate has changed in countries with fixed exchange rates.

Table 4. IT, real effective exchange rates and exports in the OECD, 2008-10 (OLS estimations)

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.	*DREER*0809	*DREER*0809	*DREER*0809	*gx*0810	*gx*0810	*gx*0810
IT	-0.0973***	-0.1029***	-0.1340***			
	(0.0161)	(0.0166)	(0.0270)			
DREER0809				-0.2655***	-0.2340***	-0.1644***
				(0.0633)	(0.0601)	(0.0506)
Constant	0.0267***	0.0323***	0.0633***	-0.0137***	-0.0114**	-0.0037
	(0.0068)	(0.0080)	(0.0225)	(0.0049)	(0.0051)	(0.0058)
Obs.	34	29	19	33	28	18
R-squared	0.551	0.555	0.451	0.308	0.302	0.203
Excluded	None	Peripheral	Eurozone	None	Peripheral	Eurozone

Notes: Columns 1 to 3 report OLS regressions of the type: $DREER0809_i = b_0 + b_1 \cdot IT_i + u_i$. The IT variable is described below Table 1. $DREER0809 = REER_{2009} - REER_{2008}$, where $REER_t$ is the real effective exchange rate (constant trade weights) in year t. Data on *REER* are from OECD (2013). Columns 4 to 6 report OLS regressions of the type: $gx0810_i = c_0 + c_1 \cdot DREER_i + u_i$, where $gx0810$ is growth of export volume between 2008 and 2010. The variable is defined as $gx0810_i = \log(X_{2010}/X_{2008})/2$, where X_t is export volume in year t, etc. Export volume data are from OECD (2013). Robust standard errors are reported in parenthesis.

Figure 3. Scatter plot of DREER against gx0810, where DREER < 0 signifies a real effective exchange rate depreciation



Consider next regressing growth of exports in the first years of the crisis on *IT* for the full sample of OECD countries. Results, which are reported in Table 5, show that IT countries have experienced faster export growth than non-IT countries. The difference is not trivial. Column 1 shows that, on average, non-IT countries saw exports *shrink* at an annual average rate of almost 2.4%, whereas IT countries saw exports *expand* by roughly 1.0%. As columns 2 and 3 show, excluding, respectively, peripheral and all eurozone countries does not change this conclusion.

So the question that remains is whether this increase in exports, possibly resulting from the real effective exchange rate depreciation, can account for (some of) the difference in growth performance between IT and non-IT countries. Table 6 shows that in fact it can. Column 1 shows that export growth alone during the initial years of the crisis can explain 27% of the variation in GDP growth over the period 2008-12.[12] In columns 2 and 3 we exclude, respectively, peripheral and eurozone countries. This does not change anything fundamentally, although the coefficient on *gx*0810 is estimated somewhat imprecisely in column 3.

[12] We have also investigated whether the difference in export volume growth between IT and non-IT is a trend phenomenon. It is not. The growth rate of the export volume prior to the crisis (2002-06) was the same (statistically speaking) across monetary regimes. This changed after the crisis (2008-10), where it (as noted in the text) became much higher in IT countries.

Table 5. IT and export growth in the OECD, 2008-10 (OLS estimations)

	(1)	(2)	(3)
Dep. Var.	*gx*0810	*gx*0810	*gx*0810
IT	0.0335***	0.0329***	0.0297**
	(0.0095)	(0.0097)	(0.0130)
Constant	-0.0237***	-0.0232***	-0.0199*
	(0.0066)	(0.0068)	(0.0108)
Obs.	33	28	18
R-squared	0.284	0.305	0.167
Excluded	None	Peripheral	Eurozone

Notes: The table reports OLS regressions of the type: $gx0810_i = d_0 + d_1 \cdot IT_i + u_i$. The *IT* variable is described below Table 1. Growth of export is defined below Table 4. Robust standard errors are reported in parenthesis.

Note then that column 4 indicates that IT also worked through other channels than exports. The result is also confirmed when we replace the export measure in column 4 by the change in the real effective exchange rate in column 5. This is an important finding as it shows that although part of the positive post-crisis effect of IT is likely to have run through a larger real depreciation, and hence better export performance, there seems to be more to IT than this, e.g. the possibility of conducting more activist monetary policy. For example, the lower Swedish interest rate did not only depress the real exchange rate, but is also likely to have spurred domestic demand (see also Eichengreen and Sachs, 1985).

4. Empirical analysis: Extended sample

In this section we extend the sample with non-OECD countries. The benefit from this exercise is obviously that we increase the generality of our results, while the downside is that data quality deteriorates in a non-trivial manner. GDP data for some of the world's poorest countries are of extremely poor quality (see, e.g. Jerven, 2013).[13] Furthermore, we cannot pursue the same "selection on observables" control strategy, as *GAP*, *PR* and *DEBT* are not readily available for many countries.

[13] We use real (constant 2005 USD) GDP per capita data from the World Development Indicators 2013.

Table 6. IT, export growth and average annual GDP growth in the OECD, 2008-12 (OLS estimations)

	(1)	(2)	(3)	(4)	(5)
Dep. Var.	*g*0812	*g*0812	*g*0812	*g*0812	*g*0812
*gx*0810	0.3025**	0.1965**	0.1433	0.1938	
	(0.1108)	(0.0835)	(0.1231)	(0.1235)	
IT				0.0128**	0.0259***
				(0.0054)	(0.0078)
DREER					0.0506
					(0.0650)
Constant	0.0048*	0.0076**	0.0100**	-0.0019	-0.0079**
		(0.0028)	(0.0029)	(0.0037)	(0.0038)
Obs.	33	28	18	33	34
R-squared	0.272	0.158	0.061	0.361	0.319
Excluded	None	Peripheral	Eurozone	None	None

Notes: Columns 1 to 3 report OLS regressions of the type: $g0812_i = e_0 + e_1 \cdot gx0810_i + u_i$. The *g*0812 and *gx*0810 variables are described below Table 1 and Table 4, respectively. Columns 4 and 5 report regressions of the type: $g0812_i = f_0 + f_1 \cdot Z_i + f_2 \cdot IT_i + u_i$, where Z is *gx*0810 in column 4 and *DREER* in column 5. The *IT* variable is described below Table 1, and *DREER* below Table 4. Robust standard errors are reported in parenthesis.

With respect to the classification of the monetary regime for the non-OECD countries, we follow Rose (2014), which, in turn, is based on the IMF's de facto classification as reported in the Annual Report on Exchange Arrangements and Exchange Restrictions (AREAER).[14] Rose operates with three categories of monetary regimes: hard fix, floating with an inflation target, and the rest. Hard fix means a fixed exchange rate regime in the form of either: a) no separate legal tender, b) a currency board arrangement or c) a conventional peg. The second group are the IT countries with a floating exchange rate and an independent central bank targeting inflation, while the residual group contains a variety of monetary regimes including soft fixes and floaters with targets other than inflation. To make the analysis in this section directly comparable to that of the previous section, where most countries followed either an IT or a fixed exchange rate strategy, we exclude the rest category from the sample to begin with. That is, we start by only comparing inflation targeting with a fixed exchange rate (the latter group being the omitted category).

Rose refines his sample further, as do we, by requiring that the regime must be maintained continuously throughout the period; i.e. it must be *durable*.[15] There are 60 such durable hard-fix regime countries when eurozone countries are excluded.[16] When the eurozone is included,

[14] Data can be downloaded from Rose's webpage (http://faculty.haas.berkeley.edu/arose/).

[15] Rose requires durability over the period 2006-12, while we have opted for 2007-12. This choice makes no difference to the results. In fact, for the IT countries, only Ghana changes status from 2006-07. Interestingly, the central bank in Ghana actually claims to have pursued IT 'unofficially' since 2005.

[16] The 60 countries with a durable hard fix are: Antigua and Barbuda, Aruba, Bahamas, Bahrain, Barbados, Belize, Benin, Bhutan, Bosnia and Herzegovina, Brunei, Bulgaria, Burkina Faso, Cameroon,

the size of this group is 74 countries.[17] With respect to IT countries, there are 27 durable inflation targeters in the group of all inflation-targeting countries.[18]

We work with three different samples in this section. Sample 1 includes the group of 27 durable inflation-targeting countries and the group of 60 durable hard-fix countries; i.e. there are 87 countries in sample 1. Sample 2 adds the eurozone countries to sample 1, so there are 101 countries in sample 2. The two samples allow us to compare in a 'clean' way the relative performance of the two groups with well-defined monetary regimes. For completeness, however, we will also report on what happens in the full sample when all countries for which data exist are included in the empirical analysis and when we don't discern between durable and non-durable regimes. Sample 3 thus includes 190 countries.

4.1 Panel growth regressions

For estimation purposes, we use the standard growth-regression framework. This framework has often been used to gauge the impact of monetary regimes on economic growth (see Tavlas et al., 2008 for an extensive list of literature references). More specifically, consider the following growth regression in a panel-data setting:

(2) $$g_{it} = a_0 + a_1 \cdot \log(y_{it-1}) + a_2 \cdot IT_i + \sum_{s=2}^{T} \gamma_s \cdot d_{s,it} + \sum_{j=2}^{J} \gamma_j \cdot d_{j,i} + u_{it}$$

In equation (2), $g_{it} = \log(y_{it}/y_{it-1})$, where $\log(y_{it-1})$ is the (log of) one-period lagged real GDP per capita, IT_i the durable inflation-targeting dummy (the omitted category is hard-fix regimes), $d_{s,it}$ is a time dummy equal to one if $t = s$ and equal to zero otherwise, and $d_{j,i}$ is a regional dummy equal to 1 if country i is located in region j and zero otherwise.

Table 7 reports the results from the estimation of equation (2) using random-effects estimation on a panel covering the years 2007-12. Several things should be noted. First, the IT point estimate is positive and significant at the 1% level in all columns. Second, the IT point estimate stays the same regardless of whether the eurozone is excluded (columns 1 and 3) or included (columns 2 and 4). Third, the IT point estimate is very close to that found in the cross-sectional exercise using only OECD data in the previous section. Consequently, we conclude that the correlation between IT and economic growth during 2007-12 is not limited to the OECD sample. When comparing all the durable IT regimes with all the durable hard-fix regimes, the former group has significantly outperformed the latter during the 2007-12 period.

Cape Verde, Central African Republic, Chad, Comoros, Congo (Rep.), Cote d'Ivoire, Denmark, Djibouti, Dominica, Ecuador, El Salvador, Equatorial Guinea, Eritrea, Fiji, Gabon, Grenada, Guinea-Bissau, Hong Kong, Jordan, Kiribati, Latvia, Lesotho, Libya, Lithuania, Mali, Marshall Islands, Micronesia, Montenegro, Morocco, Namibia, Nepal, Niger, Oman, Palau, Panama, Qatar, Samoa, San Marino, Saudi Arabia, Senegal, St. Kitts and Nevis, St. Lucia, St. Vincent and the Grenadines, Swaziland, Timor-Leste, Togo and United Arab Emirates.

[17] The eurozone countries are: Austria, Belgium, Cyprus, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Slovenia and Spain. Note that Germany is missing, which is because Rose (2014) does not include Germany in his dataset. We have chosen to follows his lead, because it is very difficult to say whether Germany is indeed a hard fix or in fact something else; being the biggest economy in the eurozone, Germany obviously receives special attention by the ECB.

[18] The 27 inflation targeters are: Armenia, Australia, Brazil, Canada, Chile, Colombia, Czech Republic, Ghana, Guatemala, Hungary, Iceland, Indonesia, Israel, Korea (Rep.), Mexico, New Zealand, Norway, Peru, Philippines, Poland, Romania, South Africa, Sweden, Switzerland (not coded as IT regime in AREAER 2012), Thailand, Turkey and United Kingdom.

Table 7. IT and GDP per capita growth, extended sample, 2007-12 (Random effects panel estimation)

	(1)	(2)	(3)	(4)
Dep. Var.	*g*	*g*	*g*	*g*
IT	0.0169***	0.0167***	0.0160***	0.0168***
	(0.0053)	(0.0041)	(0.0044)	(0.0038)
Log(y_{t-1})	-0.0085***	-0.0082***	-0.0103***	-0.0100***
	(0.0021)	(0.0016)	(0.0029)	(0.0026)
Constant	0.0980***	0.0993***	0.1143***	0.1143***
	(0.0175)	(0.0143)	(0.0241)	(0.0224)
Time FE	Yes	Yes	Yes	Yes
Regional FE	No	No	Yes	Yes
R-squared	0.221	0.265	0.237	0.279
Obs.	506	590	506	590
Countries	87	101	87	101
Excluded	Eurozone	None	Eurozone	None

Notes: The table estimates a panel growth regression of the following type: $g_{it} = a_0 + a_1 \cdot \log(y_{it-1}) + a_2 \cdot IT_i + \sum_{s=2}^{T} \gamma_s \cdot d_{s,it} + \sum_{j=2}^{J} \gamma_j \cdot d_{j,i} + u_{it}$, where $g_{it} = \log(y_{it}/y_{it-1})$, $\log(y_{it-1})$ is the (log of) one-period lagged real GDP per capita, IT_i the durable inflation targeting dummy (omitted category is hard-fix regimes), $d_{s,it}$ is a time dummy equal to one if $t = s$ and equal to zero otherwise, and $d_{j,i}$ is a regional dummy equal to 1 if country i is located in region j and zero otherwise. Data on real GDP per capita are from World Development Indicators 2013; data on monetary regimes are from Rose (2014). In columns 1 and 2 we have imposed the assumption that the $\gamma_j's = 0$; in columns 3 and 4, we estimate the full model. The regions are: East Asia & Pacific, Europe & Central Asia, Latin America & Caribbean, Middle East & North Africa; North America, South Asia; and Sub-Saharan Africa. The regional groupings are taken from World Development Indicators 2013. All standard errors are clustered at the country level.

4.2 Instrumental variables (IV) regression

In order to take the potential endogeneity of the monetary regime into account, Table 8 reports IV estimation results using (the log of) total population as an instrument for IT. The rationale is that smaller economies are more likely to adopt a fixed exchange rate, whereas larger economies are more likely to adopt an IT regime (see e.g. Rose, 2014). Moreover, scale effects are not a feature of economic growth at the country level (see e.g. Romer, 2006), for which reason the exclusion restriction should be valid. In other words, population size should have no *direct* effect on economic growth or an effect through other channels, but only an *indirect* effect running through the monetary regime.

In column 1 of Table 7 we estimate the model using sample 1 (the sample without eurozone countries) and 2SLS (two-stage least-squares). The first thing to notice is that the instrument is very strong; a conclusion that follows immediately upon noting that the *F*-statistic from the first stage is in excess of 94. In column 2 we use sample 2 instead (i.e. we add the eurozone countries to sample 1). This does not change the basic message of column 1; indeed, the point estimate is the same and the instrument remains very strong. Without over-identification we cannot perform formal OID (over-identification) tests. An informal alternative to OID is to simply add the instrument to the regression. Validity of the exclusion restriction would suggest that the instrument is insignificant once IT is controlled for.

Inspection of column 3 of the table reveals that this is indeed the case. Finally, in columns 4-6, we add regional fixed effects to the model and perform a similar exercise to that of columns 1-3. The message emerging from columns 4-6 is exactly the same as that emerging from columns 1-3.

The IT point estimates in Table 8 are slightly larger than those reported in Table 7. However, the difference is not statistically significant. Overall, therefore, IV leads to similar conclusions as random effects estimation.

Table 8. IT and GDP per capita growth, extended sample, 2007-12 (2SLS (IV) and random effects (RE) panel estimation)

	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Var.	*g*	*g*	*g*	*g*	*g*	*g*
Estimator	IV	IV	RE	IV	IV	RE
IT	0.0219***	0.0219***	0.0146***	0.0213***	0.0211***	0.0149***
	(0.0062)	(0.0070)	(0.0055)	(0.0058)	(0.0062)	(0.0057)
Log(y_{t-1})	-0.0083***	-0.0080***	-0.0081***	-0.0091***	-0.0089***	-0.0098***
	(0.0017)	(0.0014)	(0.0017)	(0.0027)	(0.0025)	(0.0027)
Log(*pop*)			0.0008			0.0007
			(0.0010)			(0.0012)
Constant	0.0946***	0.0960***	0.0860***	0.1017***	0.1031***	0.1033***
	(0.0147)	(0.0132)	(0.0254)	(0.0227)	(0.0217)	(0.0319)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Regional FE	No	No	No	Yes	Yes	Yes
R-squared	0.219	0.263	0.267	0.236	0.278	0.280
F first stage	94.08	44.07		133.62	66.58	
Obs.	506	590	590	506	590	590
Countries	87	101	101	87	101	101
Excluded	Eurozone	None	None	Eurozone	None	None

Notes: The table estimates equations of the type: $g_{it} = a_0 + a_1 \cdot \log(y_{it-1}) + a_2 \cdot IT_i + \sum_{s=2}^{T} \gamma_s \cdot d_{s,it} + \sum_{j=2}^{J} \gamma_j \cdot d_{j,i} + u_{it}$. For information on variable definitions and sources, see notes below Table 7. In columns 1 to 3 we have imposed the assumption that the $\gamma_j^{\prime}\ s = 0$; in columns 4 to 6, we estimate the full model. Columns 2 and 5 use 2SLS estimation with (the log of) total population as instrument for *IT*. Columns 3 and 6 check the exclusion restriction by adding total population to the outcome equation. All standard errors are clustered at the country level. "F first stage" refers to the F test of the null hypothesis that population is zero in the first-stage equation.

4.3 Treatment-effects regression

There is an interesting alternative to 2SLS estimation, which allows us to gauge the consequences of endogeneity by exploiting directly the fact that the (potential) endogenous regressor, *IT*, is a binary variable. In particular, the so-called 'treatment-effects model' also assumes that the conditional mean is linear, but it adds more structure, first, by changing the first-stage model to be a latent-variable model and, second, by assuming that the error terms of the regression equation and the selection equation are bivariate normal. If the normality assumption is untenable, this identification strategy is obviously fragile; if it is tenable, the treatment effects model will provide increased precision of the estimation.

More formally, the treatment-effects model adds the following latent variable equation to equation (2) to form a system of equations:

(3) $IT_{it}^{*} = b_0 + b_1 \cdot \log(\text{population}_{it}) + e_{it}$

$IT_{it} = 1$ if $IT_{it}^{*} > 0$, and zero otherwise. Furthermore, (u_{it}, e_{it}) follow a bivariate normal distribution with covariance matrix:

$$\begin{bmatrix} \sigma^2 & \rho\sigma \\ \rho\sigma & 1 \end{bmatrix}$$

The average treatment effect is then given as

(4) $E\left(g_{it} \middle| IT_i = 1, y_{it-1}, d_{s,it}, d_{j,i}\right) - E\left(g_{it} \middle| IT_i = 0, y_{it-1}, d_{s,it}, d_{j,i}\right) = a_2 + \rho \cdot \sigma \cdot \lambda_{it}$

In equation (4), $\lambda_{it} = \phi_{it}/(\Phi_{it}(1 - \Phi_{it}))$, where ϕ_{it} and Φ_{it} are the standard normal density and the standard normal cumulative distribution function, respectively.[19] The treatment-effects model can be implemented using full maximum likelihood estimation.[20]

Table 9 reports results from full maximum likelihood estimation of the treatment-effects model. A quick look at the table reveals that IT is always statistically significant at the 5% level. Moreover, the IT point estimate is once again very similar in size to that reported in the cross-sectional regressions on the OECD sample (Tables 2 and 3), the panel random-effects growth regressions on the extended sample (Table 7) and the IV panel growth regressions on the extended sample (Table 8).

Table 9. IT and GDP per capita growth, extended sample, 2007-12 (Treatment-effects estimation)

	(1)	(2)	(3)	(4)
Dep. Var.	*g*	*g*	*g*	*g*
IT	0.0179***	0.0180**	0.0172***	0.0174**
	(0.0060)	(0.0071)	(0.0057)	(0.0068)
Log(y_{t-1})	-0.0074***	-0.0077***	-0.0085***	-0.0088***
	(0.0026)	(0.0016)	(0.0030)	(0.0026)
Constant	0.0886***	0.0940***	0.0990***	0.1041***
	(0.0225)	(0.0159)	(0.0262)	(0.0231)
Time FE	Yes	Yes	Yes	Yes
Regional FE	No	No	Yes	Yes
Obs.	506	590	506	590
Countries	87	101	87	101
Excluded	Eurozone	None	Eurozone	None

Notes: The table estimates an average treatment effect of the type: $E\left(g_{it} \middle| IT_i = 1, y_{it-1}, d_{s,it}, d_{j,i}\right) - E\left(g_{it} \middle| IT_i = 0, y_{it-1}, d_{s,it}, d_{j,i}\right) = a_2 + \rho \cdot \sigma \cdot \lambda_{it}$ using the treatment-effects methodology. The treatment-effects model assumes that the conditional mean is linear, as in equation (2), but it adds more

[19] In the text, we have suppressed the fact that ϕ_{it} and Φ_{it} are functions of the log of population.

[20] We use the treatreg command in Stata. Textbook presentations of the treatment-effects model are given in e.g. Cameron and Trivedi (2005, ch. 25), Greene (2008, ch. 24), and Guo and Fraser (2010, ch. 4).

structure than IV, first, by changing the first-stage model to be a latent-variable model and, second, by assuming that the error terms of the regression equation and selection equation are correlated bivariate normal. For information on variable definitions and sources, see notes below Table 7. All standard errors are clustered at the country level.

4.4 Additional robustness checks

A final check of the robustness of our results consists of performing the analysis on the full sample of countries for which data are available. Here we compare IT regimes with all alternative regimes, and we do not pay attention to whether monetary regimes are durable or not. That is, we simple re-estimate our model in (2) on the full sample, with the key difference being that the *IT* variable is now time-varying (IT_{it}) as opposed to time-invariant (IT_i) as in equation (2). Table 10 provides the results.

Inspection of Table 10 shows that the coefficient of *IT* is always statistically significant regardless of which estimator we use. Moreover, columns 1 and 4 reveal that random effects estimation on the full sample delivers slightly smaller estimates than in the restricted (durable regimes) sample of Table 7, but the difference is not statistically significant. Columns 2 and 5 (3 and 6) show that correcting for potential endogeneity of IT using 2SLS (treatment effects) leads to slightly higher estimates, but again the difference is not statistically significant.

Consequently, using all countries for which data are available and allowing monetary regimes to be both durable and non-durable does not change (statistically speaking) any of the results presented in this paper. Furthermore, the results show that when we compare IT regimes with all other regimes, we still find that IT regimes outperform the others as a group.

Table 10. IT and GDP per capita growth, extended sample with all countries, 2007-12 (Random effects (RE), 2SLS (IV) and treatment-effects (TE) panel estimation)

	(1)	(2)	(3)	(4)	(5)	(6)
Estimator	RE	IV	TE	RE	IV	TE
Dep. Var	*g*	*g*	*g*	*g*	*g*	*g*
IT	0.0103***	0.0321**	0.0343**	0.0092**	0.0259*	0.0299**
	(0.0037)	(0.0154)	(0.0134)	(0.0037)	(0.0133)	(0.0152)
Log(y_{t-1})	-0.0073***	-0.0082***	-0.0066***	-0.0086***	-0.0086***	-0.0076***
	(0.0013)	(0.0015)	(0.0013)	(0.0017)	(0.0018)	(0.0017)
Constant	0.0994***	0.1040***	0.0899***	0.1181***	0.1152***	0.1069***
	(0.0108)	(0.0116)	(0.0117)	(0.0137)	(0.0137)	(0.0143)
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Regional FE	No	No	No	Yes	Yes	Yes
Obs.	1,094	1,094	1,094	1,094	1,094	1,094
F first stage		22.22			23.54	
R-squared	0.209	0.179		0.234	0.217	
Countries	190	190	190	190	190	190

Notes: The table re-estimates columns 2 and 4 of Table 7 (columns 1 and 4), columns 2 and 5 of Table 8 (columns 2 and 5), and columns 2 and 4 of Table 9 (columns 3 and 6) using all countries for which data is available. Moreover, monetary regimes are both durable and non-durable; i.e. *IT* is a time varying variable. See the respective tables for information on variable definitions and data sources. All standard errors are clustered at the country level.

5. Concluding remarks

In this paper we have shown that OECD countries with an IT monetary policy framework have systematically outperformed OECD countries with other regimes (predominantly fixed exchange rates) in terms of economic growth during the period 2007-12. We have also shown that part of this outperformance can likely be ascribed to the exchange rate flexibility of the IT countries and hence to an improved export performance resulting from currency depreciations. Nevertheless, our analysis also shows that there seems to be more to IT than simple beggar-thy-neighbour effects. Thus, when controlling for improved export performance (or real depreciations), we still find a significantly positive (residual) effect of IT compared to non-IT countries. This could for example be due to independent effects of a more aggressive monetary policy, i.e., effects not running through the exchange rate. Identifying the exact transmission mechanism is an area where further research is warranted.

Moreover, as a robustness check, we have also compared IT regimes with fixed exchange rate regimes on an extended sample of more than 100 countries using random effects, 2SLS and treatment effects regressions. All analyses confirmed the positive relationship between IT and economic growth since the Great Recession.

It would be imprudent to claim that one monetary policy regime always and everywhere dominates all other regimes. However, we trust that our empirical analysis demonstrates that the choice of monetary regime is *not* irrelevant, as e.g. Rose (2011, 2014) claims it is. Indeed, our results indicate that the choice of monetary regime can be very important for economic growth – especially in times when flexibility matters the most, which is arguably when a huge adverse shock hits as it did in 2007-08. Our findings thus echo one of the important policy lessons learned from the 1930s (see Eichengreen and Sachs, 1985; Bernanke, 1995), namely the important role played by currency depreciation (i.e. going off gold) in escaping the negative growth dynamics of the Great Depression.

The basic insight of our paper is particularly important at the current juncture, where there is little debate and/or consensus about the cost and benefits of the different monetary and exchange rate regimes. For example, this type of analysis, which suggests tangible growth benefits of an IT regime with a flexible exchange rate in a crisis situation compared to (at least) a fixed exchange rate regime, should be a part of the set of considerations for eastern European countries considering joining the euro, and other countries are considering abandoning a flexible exchange rate regime.

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Appendix

Table A1. IT and average growth in the OECD, 2007-12 (OLS growth regressions, alternative debt measure)

	(1)	(2)
Dep. Var.	*g*0712	*g*0812
IT	0.0072*	0.0085*
	(0.0041)	(0.0048)
GAP	-0.0043***	-0.0050***
	(0.0014)	(0.0017)
gPY	0.0297	0.0308
	(0.0216)	(0.0248)
PR	-0.0002*	-0.0001
	(0.0001)	(0.0001)
DEBT	-0.0002*	-0.0002
	(0.0001)	(0.0001)
Constant	0.0375**	0.0381**
	(0.0147)	(0.0178)
Observations	25	25
R-squared	0.627	0.636

Notes: The table re-estimates column 4 of Tables 2 and 3 using general government gross financial liabilities to GDP instead of gross debt to GDP (Maastricht criterion), the latter being used in Tables 2 and 3. Robust standard errors are reported in parenthesis.

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